10065

Regolith Breccia

347 grams

Figure 1: Butt end of lunar breccia 10065,7. Sample is 6 cm across. Cube is 1 cm. NASA S76-22547.

Introduction

Lunar sample 10065 is a moderately coherent regolith breccia (Fruland 1983, Simon et al. 1984). 10065 had a hemispherical shape with one broken side and the top surface was covered with glass-lined micrometeorite pits (Schmitt et al. 1970).

Petrography

Schmitt et al. (1970) reported the bulk density as 2.45 g/cm^3 and note that "*the fragments are coarser on the average in this breccia than in the other breccias"*. Phinney et al. (1976) considered this breccia a moderately-coherent, vitric microbreccia with a matrix porosity of about 10 %. Using SEM petrography they found that it was welded together with glass with many very fine particles.

Simon et al. (1984) included breccia 10065 in their comprehensive study of Apollo 11 regolith breccias –

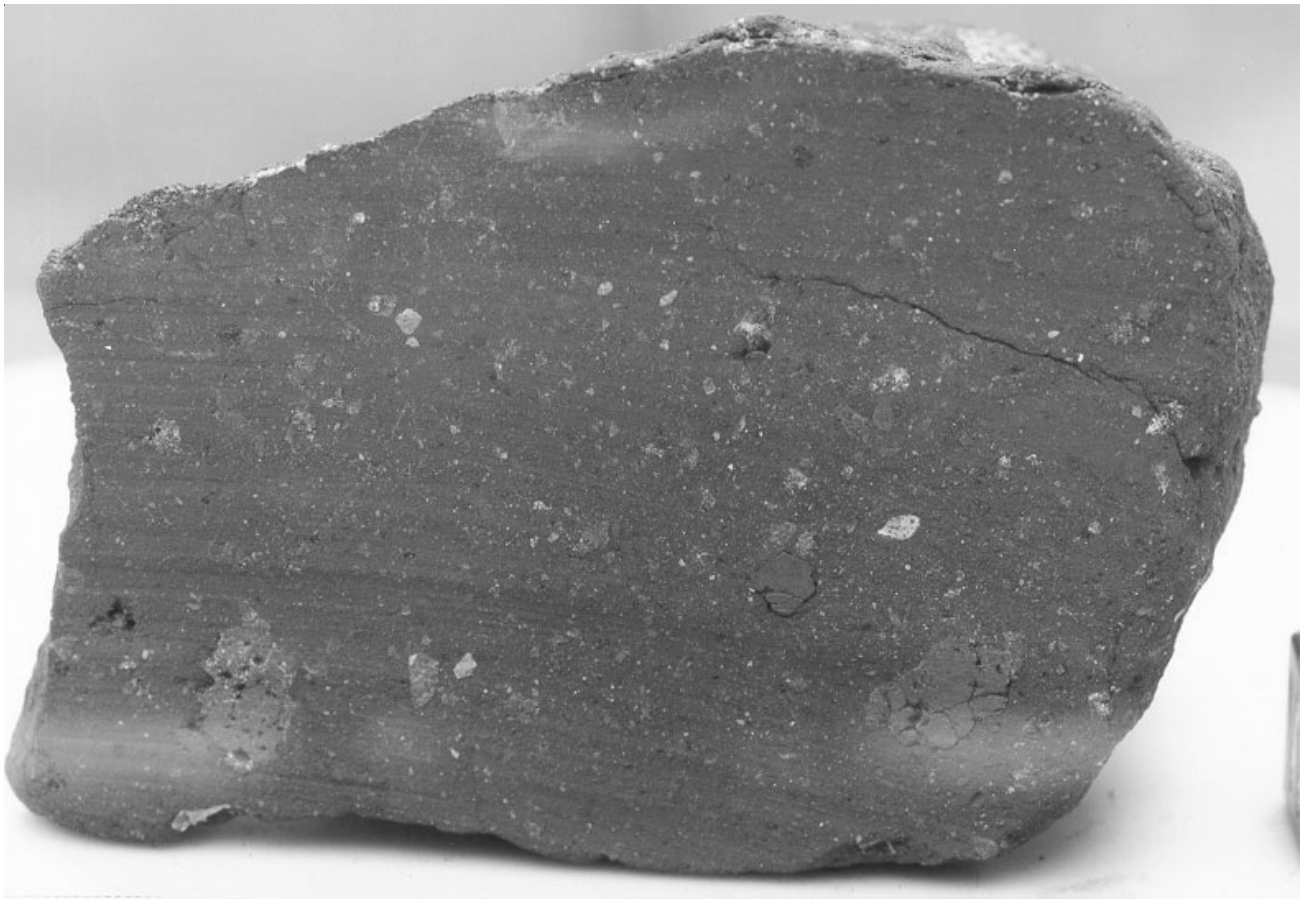

Figure 2: Photo of sawn surface of 10065,7 showing dark aphanitic clasts. Sample is 6 cm across. NASA S76-22549.

their mode is given in the table. They calculated that it had about 24% highland component, but couldn't directly identify that many clasts of highland rock.

Chao et al. (1971) determined the mineralogical mode, studied shock features in 10065 and give analysis of several glass particles. Dence et al. (1970) and Quaide and Bunch (1970) also discuss the shock features in 10065 and give mineral compositions. They note the diaplectic plagioclase glass with composition An_{90} indicates shock pressure 350 to 500 kbars. Chao et al. (1970) illustrate a thin section across a micrometeorite crater illustrating the glass lining and the penetration of the glass into the matrix.

McKay and Morrison (1970) favored a hot welded origin for the Apollo 11 breccias, while Chao et al. (1971) favored a cold, shocked-pressed origin because of the high gas content.

Mineralogical Mode

	Chao et al. 1971
Basaltic rock	21.2
Anorthositic rock	1
Mineral fragments	6.6
Glass-welded aggregate	12.4
Devitrified glass	3.8
Heterogeneous glass	3.3
Homogeneous glass	3.1
Basaltic microbreccia	0.3
Anorthositic breccia	0.3
Shocked	0.1
Less than 25 microns	29.5
Pore space	18.4

Simon's Mode

	S	**L**
Mare Basalt	4.8	10.5
Highland Component	1.1	0.4
Regolith breccia	5.1	2
Agglutinate	7.4	2.8
Pyroxene	5.5	
Olivine	0.2	
Plagioclase	3.8	
Ilmenite	0.7	
Orange glass	3.7	0.5
Other glass	1.8	0.4
Matrix	49.3 %	

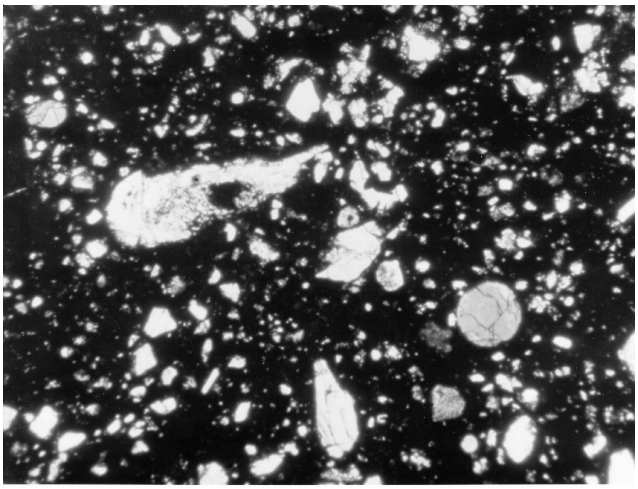

Figure 3: Photomicrograph of thin section of 10065 showing mineral fragments and orange glass beads in fine matrix. Scale is 2.5 mm. NASA S-70-19544.

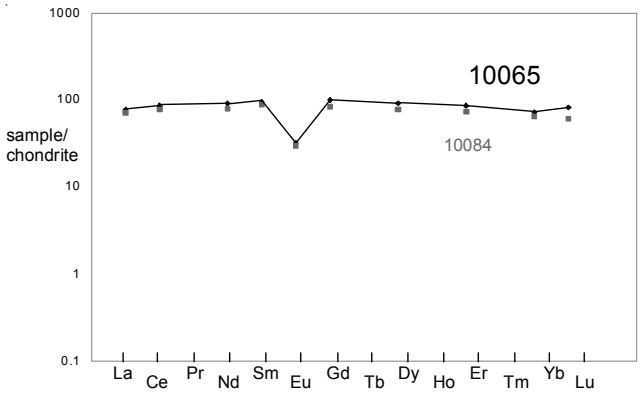

Figure 4: Normalized rare earth element diagram for breccia 10065 compared with soil 10084 (data from Wiesmann et al. 1975).

Mineralogy

Armalcolite: Agrell et al. (1970) show pictures of armalcolite with ilmenite and rutile found in 10065.

Glass spheres: Chao et al. (1970, 1971) and von Engelhardt et al. (1970) reported the composition of glass spheres in 10065 including the redbrown variety of presumed volcanic origin.

Glass: Dence et al. (1970) give the compositions of some "recrystallized" glass particles in 10065. Chao et al. (1971) reported on the wide variety of glass textures and compositions, all within one breccia (10065).

Chemistry

Goles et al. (1970), Annell and Heltz (1970), Wiesmann and Hubbard (1975) and Rhodes and Blanchard (1981) analyzed 10065. The REE are similar to the Apollo 11 soil (figure 4). Annell et al. found 169 ppm Ni, but the critical meteoritic siderophiles (Ir and Au) have never been determined. Thiemens and Clayton (1980) determined 104 ppm nitrogen (with a very negative delta ^{15}N).

Other Studies

Heymann and Yaniv (1971) determined the isotopic ratio of rare gas released during vacuum crushing of 10065. Wanless et al. (1970) determined the isotopic composition of Li, K, Rb and Sr.

Katsube and Collett (1971) determined the dielectric properties of 10065.

Processing

Apollo 11 samples were originally described and cataloged in 1969 and "re-cataloged" by Kramer et al. (1977). 10065 was cut by saw (figure 5).

List of Photo #s for 10065

S69-46627
S76-22547
S76-22549
S76-23362 – 23363

Table 1. Chemical composition of 10065.

reference	Wiesmann75		Goles70		Rhodes81		Annell70		Murthy70		Wanless70	
weight												
SiO2 %			41.3		41.9	(c)						
TiO2			7.8		7.92	(c)						
Al2O3			12.5		12.56	(c)						
FeO			16.8		16.24	(c)						
MnO			0.2	(b)	0.22	(c)	0.25	(d)				
MgO			8.3		7.86	(c)						
CaO			13.1		11.82	(c)						
Na2O			0.48	(b)	0.47	(c)						
K2O	0.18	(a)			0.18	(c)			0.17	(a)	0.18	(a)
P2O5					0.14	(c)						
S %												
sum												
Sc ppm			62.6	(b)			69	(d)				
V			84	(b)			57	(d)				
Cr			1890	(b)	2121	(c)	2390	(d)				
Co			31.6	(b)			30	(d)				
Ni							169	(d)				
Cu							14	(d)				
Zn							23	(d)				
Ga												
Ge ppb												
As												
Se												
Rb	3.8	(a)					2.8	(d)	3.69	(a)	3.74	(a)
Sr	168	(a)					140	(d)	168	(a)	165.5	(a)
Y							103	(d)				
Zr	403	(a)					390	(d)				
Nb							25	(d)				
Mo												
Ru												
Rh												
Pd ppb												
Ag ppb												
Cd ppb												
In ppb												
Sn ppb												
Sb ppb												
Te ppb												
Cs ppm												
Ba	197	(a)	220	(b)			260	(d)	200	(a)		
La	18.5	(a)	17.8	(b)			16	(d)				
Ce	52.5	(a)	63	(b)								
Pr												
Nd	41.5	(a)										
Sm	14.3	(a)	14.6	(b)								
Eu	1.82	(a)	1.73	(b)								
Gd	19.9	(a)										
Tb			4	(b)								
Dy	22.5	(a)										
Ho			6.7	(b)								
Er	13.8	(a)										
Tm												
Yb	11.9	(a)	14.5	(b)								
Lu			2.01	(b)								
Hf			12.1	(b)								
Ta			2.1	(b)								
W ppb												
Re ppb												
Os ppb												
Ir ppb												
Pt ppb												
Au ppb												
Th ppm	2.53	(a)										
U ppm	0.68	(a)	0.54	(b)								

technique: (a) IDMS, (b) INAA, (c) XRF, (d) emission spec.

Figure 5: Pieces of 10065. NASA S76-23362 and 23363. Cube is 1 cm.